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Issues related to the spatial planning of land (including minerals) and water resources

Report of the Secretary-General

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I. Introduction

1. The present report has been prepared pursuant to Economic and Social Council decision 1996/306.

2. Section II of the report identifies emerging issues in the area of land and water resources management, and places human-induced stress in the context of finite land and water resources; section III puts forward recommendations for improving the spatial planning of land and water resources.

II. Current and emerging management issues

3. Air, water and land ecosystems are intimately linked, a linkage that often comes into sharp focus when environmental balance breaks down irretrievably as a result of accelerated erosion, salinization, groundwater pollution and other similar processes whose damage goes well beyond the original source of degradation. The linkage is clearly recognized by the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, which stresses, *inter alia*, that the major threats to the health and productivity of the marine environment result from human activities on land in coastal areas and further inland. Similarly, the Food and Agriculture Organization of the United Nations (FAO) Interdepartmental Working Group on Land Use Planning defines land as a delineable area of the earth's solid surface, embracing all attributes of the biosphere above and below the surface, the soil and underlying geology, the hydrology, plant and animal populations and human settlements, and the physical results of past and present human activity. This not only highlights the interdependent nature of land and water, including lakes, rivers, wetlands and groundwater processes, but also points to the high degree of variability in resource availability.

4. Although human influence on land and water resources play a major role in many regions, it also should be seen against the background of natural processes, such as erosion and chemical cycles. Anthropogenic degradation in the form of erosion, salinization, waterlogging, depletion of fossil groundwater, pollution by non-degradable chemical substances, acidification and eutrophication have socio-economic consequences that include a decrease in land productivity for long periods of time and the need to implement costly restoration programmes. Waterlogging and associated salinization of land caused by irrigated agriculture in arid and semi-arid zones result in significant losses of agricultural land each year. In addition, land and water degradation often set off a chain of complex problems. Soil erosion leads to both the depletion of nutrients and reduced water-holding capacity, which may in turn cause siltation of river systems and reservoirs. Not only does this reduce the lifespan of reservoirs, but their reduced storage capacity may also increase the risk of flooding. If reservoirs do not act as traps for suspended material, enhanced erosion may also threaten lacustrine and marine ecosystems.

5. Mining and smelting industries have created local environmental effects throughout the world, and in the past have led to acute or chronic toxication. The effects of mineral exploitation on land and water systems depend upon a variety of factors, such as the chemical composition of the minerals, topography, methods of mining (open pit or underground mining), hydrological conditions and climate. The environmental effects of mining often extend far beyond the mining site in terms of, for example, changing groundwater flows, pollution of surface and groundwaters, deposition of wastes and windblown dust. The most serious problem is the release into the environment of harmful trace elements and heavy metals, such as lead, cadmium, arsenic and mercury, which may not only pollute local and regional water resources but can also degrade large land areas, major aquifers and eventually coastal areas. Harmful concentrations of metals can also build up in associated plant and animal life and move up the food chain to affect human health. Heavy metal pollution of water has a number of anthropogenic sources, including mining, processing of ores and particularly leaching from industrial waste dumps and mine tailings. Acidified or saline water enhances metal mobility and draws more heavy metals from mine tailings. It also transforms such metals as lead into a form more readily absorbed into living tissues, thus amplifying the toxic effects of leaching. Pollution of groundwater due to leaching processes, particularly in areas with sulphide ore deposits, can be especially serious since reclamation of the affected aquifers is technically demanding and expensive.

6. Land and water issues are multidisciplinary and include a large number of other environment and development issues, such as desertification, deforestation, biodiversity, air and water pollution, agricultural development, rural and urban development, climate change and sea level fluctuations. Although these clearly call for an integrated approach, such issues are often addressed independently, resulting in duplication and waste of financial, human and institutional resources.

7. Broadly speaking, agricultural land (and land in general) cannot be considered a fully renewable resource since in many ways it is finite. The total land area of the world is estimated at about 13 billion hectares, over half of

which lies in developing countries. According to FAO estimates, only about one tenth of the land area in these countries is currently used for crop production, and much of the agricultural land in industrialized countries is already in production. It is also estimated that 90 per cent of potential new crop land is located in the developing world, of which 95 per cent lies in Africa and South America, while the remaining 5 per cent lies in Central America and the Middle East (virtually no land is available for expansion in Asia). In any case, a considerable proportion of this "land reserve" is under forest or in protected areas, and cannot really be considered as readily available for agricultural expansion. Other constraints to agricultural expansion include conflicts over land tenure and inadequate allocation of land rights, lack of access to both credit and adequate agricultural inputs, and high costs of transportation and land clearing. In addition, approximately half of the 1.8 billion hectares of land in developing countries (excluding China) with rainfed crop potential is located in humid areas (that is, too wet for most crops and rather unhealthy for human settlement) or is considered only marginally suitable for crop production. The possibilities for expansion of land for crop production are, therefore, relatively limited. Nonetheless, it is generally accepted that world food supplies will have to double between 1995 and 2025 because of continued population growth and expected rises in income. However, in view of the constraints on future land supply, unlike previous decades when expanded land area and increased irrigated area played a major role in increasing agricultural production, most of the rise in future production is expected to come from biological yield increases (that is, the intensification of production with high-yielding crop varieties) in high-potential areas.

8. According to recent FAO estimates, while arable land may expand by 90 million hectares by 2010, the harvested area could increase by 124 million hectares because of rises in cropping intensities, with irrigated land in developing countries expanding by 23.5 million hectares from the present 186 million hectares. As a result of intensification of land use in areas that are naturally well endowed or can be made so by economically viable human activities, such as irrigation and drainage, there will be a significant decrease in the average rate of land per rural household in the near future. Per capita availability of arable land in developing countries is projected by FAO to nearly half between the late 1980s and 2010, from 0.65 to 0.4 hectares, and that figure is likely to decline even further towards 2050, when the possible adverse impacts of global climatic change on food security may become more accentuated. By contrast, the per capita amount of arable land may increase in industrialized countries given their relatively stagnant population growth. This is likely to lead to the more marginal arable lands being taken out of production as "set-aside" lands for nature development, cultural landscape conservation or recreational purposes. The situation in countries with economies in transition is more difficult to project because of the current process of the transfer of state-owned arable land to private ownership.

9. A significant part of the world's agricultural land suffers from soil degradation, salinization, desertification and waterlogging, not to mention scarce availability of water for irrigation. Moreover, the main components of land may degrade in their intrinsic quality or economic value not only as a result of inappropriate human activities but also as a result of natural processes, such as earthquakes, volcanic eruptions and the effects of climate variability. Furthermore, degradation of one component, such as human caused deforestation, can negatively affect other components, such as soil, water flow or humidity. Soil degradation is probably the most widespread and serious form of deterioration, because (a) it undermines a major life-supporting system, (b) its natural recuperation may take decades or centuries, and (c) artificial soil rehabilitation is often very expensive. It is estimated that one fifth of current irrigated land in the world is already degraded to the extent that crop reproduction is significantly reduced. The most important cause of soil degradation is overgrazing by livestock, although deforestation, unsustainable land-clearing activities and inappropriate agricultural practices have been major contributory factors in the process.

10. Economic growth and urban development will lead to further competition among various users for scarce land and water resources. Agriculture will continue to be the most important economic sector and represent the most important user of these resources in many developing countries, including some countries with limited availability of water resources. Hence, policies and programmes affecting the allocation of land and water among competing uses can have a profound impact on urban and rural development, and on the generation and distribution of economic benefits.

11. The economic and social aspects of the interaction between land and water resources are among the most neglected areas of economic and social policy. The perception of land and water resources as free environmental goods has resulted in their true values being underestimated, often leading to inefficient exploitation and environmental degradation. The often perceived result is sub-optimal allocation and market, policy and institutional failures that are widely documented.

III. Actions to improve and enhance the spatial planning of land and water resources

12. Water and land resources are so closely intertwined that a purely sectoral approach to the planning, development and management of either resource should be avoided since this may lead to their irreversible degradation. Concern about the environmental dimension of both land and water use has been highlighted by rapid world population growth, widespread land and groundwater degradation, ecological interdependencies at both national and regional levels, the growing awareness of the value of natural ecosystems and even the perception that land-use practices may influence the global climatic system. An integrated rather than sectoral approach is essential to prevent or resolve conflicts related to land and water use, since it optimizes the overall planning process and creates an enabling environment for mediation between, and decision-making by stakeholders at all stages of the planning and implementation process. In addition, another major source of conflict that must be addressed through integrated planning and management is competition between urban and rural land uses. This conflict can be expressed in various forms, such as (a) expansion of human settlements, industrial areas and peri-urban infrastructure versus protection of prime agricultural land and safe agricultural land tenure, (b) mass influx of rural poor to urban areas versus adequate availability of labour for agricultural activities (or conversely, urban unemployment), (c) competition between urban and rural water use, and (d) urban demand for timber and charcoal versus vegetative protection of upper catchments to prevent the degradation of agricultural land and water resources.

13. The report of the Panel of the Commission on Science and Technology for Development, submitted as a background document to the Inter-sessional Working Group on Sectoral Issues at the fourth session of the Commission on Sustainable Development, concluded that most of the scientific knowledge and applied technology needed for effective land resources management are available. The same is true for water management, and it is likely that countries with such problems may not be applying this knowledge effectively due to limited access to information and appropriate technologies, lack of adequate infrastructure to use available technology efficiently and institutional fragmentation, which result in uncoordinated approaches and efforts, lack of scientific and educational capacity, problems caused by current land-use practices, and unresolved conflicts between different land-use goals. In addition, the lack of human financial and organizational resources in many countries prevents people from actively participating in environmental management and policy development.

14. All countries are facing various degrees of land degradation problems, and examples of progressive practice in land and water management can be found in different climatic and physiographic zones (see box 1). In addition, numerous international conferences, papers and national experience have provided basic frameworks on which to build effective management plans. It remains a challenge to implement such knowledge into policy planning, establish the national capacity needed, identify actors, coordinate various efforts, provide an updated and accurate knowledge base, and provide the necessary financial resources.

15. There is a continuum of actions required at all levels in order to move towards overall sustainability of land and water resources. At the global and regional levels, issues to be addressed include desertification, drought and flood management, as well as other issues related to natural disaster reduction. At the regional level, there is also scope for actions to control transboundary pollution of soil and water, cooperation in the conservation and use of international waters (rivers, lakes and groundwater) and river basins, and the transfer of technology and know-how. At the national level, there is a need to implement policies to promote the sustainable use and management of land and water resources, including with regard to the identification of clear rights to land and water resources. Significant action also needs to be taken at local levels, where local development plans should aim at efficient and sustainable use of existing resources, protection of resources from quality degradation, and strengthening of local participation, especially by women and the poor, through education and public awareness campaigns and greater opportunities for local participation in planning and decision-making processes. A number of issues need to be addressed to ensure an effective integration of land and water resources management.

A. Integration of land and water resources management into national socio-economic strategies

16. Effective land and water resources planning, development and management needs to be integrated into overall national economic and social planning and strategies. National and regional development plans should also recognize that integrated land and water management policies can only succeed if they are based on broader

Box 1. Integrated land and water conservation in Keita, the Niger

Before the start of the Keita Integrated Rural Development Project, the Keita valley in the Niger was in a dramatic situation as a consequence of frequent drought years: the vegetation had almost disappeared over most of the plateaux and the "glacis" (large areas, with gentle slopes, located at the foot of valley slopes). The sandy slopes were eroding fast under the surface run-off, and the beds of the ephemeral rivers had become deeply entrenched as a consequence of water erosion. The floods that had once provided necessary moisture to the surrounding land and were used for cropping staple food no longer occurred. Now the plateaux and glacis have largely been reclaimed through water harvesting techniques consisting of building anti-erosion bunds, subsoiling and impluvium: water runs off the bare soil on to the cultivated plots below, in alternative strips parallel to the contour lines. The harvest that had disappeared is now fully restored.

River run-off occurs as high intensity flash floods of short duration. In order to attenuate its destructive effect and improve control of the overall flow pattern in the hydraulic network, the tops of small watersheds of less than 20 km^2 are controlled by building earth check-dams of lateritic material, equipped with a gabion reinforced lateral spillway, and in some instances a pipe traversing the earthen dyke. These dams capture the peak of the flood, store it temporarily and release the water over a much longer period at a low rate, which has the advantage of reducing the erosive force. The check-dams form water impoundments that last several months after the short rainy season, and provide a valuable asset for farmers and livestock. They also recharge the groundwater and in some instances allow fish farming. As the impounded water recedes during the dry season, the farmers sow off-season crops: onion, sweet potatoes, maize and even wheat and sunflower.

In the large main watercourses or "koris", floods of several hundreds of cubic metres per second do not allow the building of storage dams by using the simple techniques applied in the upper watersheds. However, in order to restore the severely eroded stream beds to their original level and slow and attenuate the flood peaks and conserve the water table, the project has erected gabion dykes one to two metres high and several hundreds of metres long across the whole of the kori bed in order to restore large-scale seasonal ponds that once formed every year but disappeared during the drought years under the effect of erosion. This has now restored the flat pond areas, which are also used for producing flood recession crops as above. Another beneficial effect is the rising of the water table, where shallow wells can be dug for more horticultural crop production. For a number of years, a hydrological network has been in place in order to measure rainfall and river run-off. Up to now, the effects of the conservation work which have been carried out are clearly visible, but it is too soon to know what the long-term outcome will be.

catchment and basin strategies. Moreover, it is increasingly clear that conventional options for purely administrative solutions to land and water management appear to have reached their limits. A consensual approach to natural resource management is thus becoming an increasingly attractive solution for resolving tensions between owners, managers and regulators of resources.

17. Any policy formulation and implementation should thus involve all stakeholders as early as possible in the process, and should include those that are affected by any action, those who possess knowledge and expertise, and those who control the relevant instruments for successful implementation of policies and actions. The focus of the problem may be global, since all regions of the world to some extent suffer from various types of degradation problems, but national Governments have the main responsibility for dealing with national degradation problems, possibly with support from the international community. In addition, it is important to recognize the areas that need special attention, including irrigated lands, drylands, areas with large seasonal variations in precipitation, areas experiencing extensive deforestation, and mountains and other areas with a steep topography.

18. Estimating the full economic value, including environmental and amenity assets, of land and water poses particular problems, and a range of solutions have been employed by economists and their respective institutions. Some examples on how to place a value on the public good benefits of water are discussed in a recent World Bank report.[1] Economic valuation of water-related investments in development and management of irrigation, hydropower, urban and rural water supply and sanitation, drought prevention and flood control is important because it aids in determining the worth to people of proposed projects and in estimating the degree to which they are willing to pay for benefits. In the prevalent situation of constrained public budgets, conceptually correct and empirically valid estimates of the economic contribution of both land and water in each water-using or land-use sector are essential for making economically sound investment decisions.

B. Land, water and food security

19. Greater attention needs to be given to the vital role of land and water resources in food production. It can be argued that there are at least three crucial preconditions required to close the threatened gap between food production and consumption: sustainable water development, appropriate government policies, and an educated labour force with high-quality technical support. These three conditions are evidently linked. Water shortage is becoming a critical development constraint. Water resources, which until quite recently were considered cheap and plentiful, are now fully recognized to be relatively scarce and valuable. Good governance, including the maintenance of local and regional security as well as sound macroeconomic management, is necessary to promote agricultural investment and its profitability. Sustainable agricultural development requires a range of production inputs and profitable markets. Productive agriculture also requires a wide range of technical skills, including water management skills and specialist support, either in the public or the private domain. Furthermore, as clearly expressed in a recent Economic and Social Council review and analysis of agrarian reform and rural development (see E/1996/70), it is increasingly recognized by United Nations Member States that the market (even if regulated) is the most effective land distribution mechanism. The market is also generally seen as the most appropriate means for reducing unequal patterns of land distribution and for promoting more efficient land use, although experience shows that corresponding participatory and democratic policy interventions reforms and effective regulation are also necessary.

C. Land, water and health

20. With water as a primary agent in maintaining human health and transmitting disease, there is an imperative need to manage land and freshwater sources to maintain chemical and biological quality to minimum acceptable standards. Key actions that will work towards the protection and improvement of water quality include (a) priority for sanitation, sewage treatment and control of discharges of industrial effluents and run-off of pesticides and fertilizers, (b) monitoring of bacteriological and parasitic water-borne diseases at the basin level, and (c) prevention or minimization of contamination of land and water by heavy metals and other chemicals.

D. Protection of land and water ecosystems

21. The balance between environment and development needs to be founded on a clear understanding of the environmental systems and the resources that they can furnish without compromising their overall long-term integrity. The economic implications of environmental degradation and ignorance of climatic variability can account for significant percentages of gross domestic product in lost productivity. As mentioned above, a number of environmentally sound development policies to avoid or mitigate damaging impacts on land and water ecosystems

have been formulated by various national and international bodies, including the body of recommendations related to the implementation of United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa, the Convention on Biological Diversity, the Convention on Wetlands of International Importance, Especially as Waterfowl Habitat (Ramsar Convention) and the United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses.

E. Information management and monitoring systems

22. The continuous monitoring of environmental changes is crucial for economic and social planning at both the national and regional levels. The adaptation to changes (natural as well as human induced) that take place in the landscape requires that information on such changes be periodically gathered and analysed. It is useful, however, to note that the financial costs of establishing, operating and maintaining monitoring systems can be high and beyond the means of many developing countries unless financial (and technological) assistance is provided. This calls for careful cost-benefit analyses that take account, *inter alia*, of the limitations of these systems and the possible benefits that they will provide, including (a) the provision of adequate and accurate information to decision makers, (b) the ability to detect changes in the landscape, including natural or human-induced disasters) so that appropriate measures can be taken to deal with them, and (c) the ability to detect natural and man-made disasters so that appropriate action can be taken to prevent them or the mitigating effects that follow them.

23. Disasters, natural as well as human induced, are often related to land and water systems, such as floods, droughts and mud-flows. When they occur, there is a need for rapid and coordinated responses and actions from local, national and international organizations. If data and information are available and continuously updated, changes that may eventually cause a disaster, such as deteriorating water and soil quality (including salinization), changes of the groundwater table, top soil loss, floods and mud-flows, may be detected and actions can be undertaken in advance. When disasters occur, communication systems and infrastructure are often severely damaged, which means that coordinated actions can be difficult. In many cases, remote sensing has proven to be the only tool for keeping rescue workers and planners continuously informed on the emerging development. National and regional capacity to gather and evaluate information that is relevant to disaster prevention need to be strengthened, including through international financial and technological assistance, if required.

24. Any monitoring programme developed to study relationships between land and water needs to be cross-sectoral, both within the scientific community and between researchers and policy makers, in order to present a comprehensive set of policy options to decision makers. Comprehensive studies on the reasons behind poor land and water management practices should not only focus on physical constraints in the environment but should also examine pricing policies, land access issues, subsidies, taxes, environment laws, the role of land and water resources in social and economic development, local customs and indigenous knowledge. There is also a need to have an open discussion on further data needs and how to integrate information systems to better address environment issues related to land and water management. The question of addressing issues from a river basin perspective fall into this category. Organizations and Governments have ambitious programmes but information, if available, is often scattered and sectoral, which makes it difficult to prepare detailed assessments and propose effective management strategies. It is also important to define data and information needs for each country and region within countries since areas with a complex and changing environment or where land use is intensive will require dense monitoring systems, while more homogenous and sparsely populated areas may require less coverage.

25. The overall objective should be that countries and international organizations enhance ongoing efforts, both national and international, to collect and analyse data and information about the physical, social and economic environment that can be applied to the watershed level (or any other appropriate spatial level). Financial and technical assistance should be given to developing countries to formulate and implement national programmes in the area of data collection, analysis and exchange. National geographical information systems should be particularly developed and supported, and their databases should be systematically updated and expanded, as required. Scientific cooperation among universities could be one step in the right direction. It could be possible from this system to retrieve information and data sets on physical, social, economical and environmental conditions and parameters, and to integrate them at the desired spatial scale, for example covering a specific river basin or sub-basin.

F. Institutional and legal framework and capacity-building

26. In order to implement integrated land and water policies, countries need to define appropriate spatial and temporal scales, at both the national and local levels, for the formulation and implementation of relevant development and conservation programmes, including monitoring systems. It is important to recognize that although the basic problems of land and water management have many similarities around the world, local variations in the physical environment and social and economic conditions require that technological and managerial solutions be adapted to local conditions.

27. Large river basins may not be amenable to single basin management approaches developed for small-scale basins or sub-basins. It is important, however, that national (and to some extent regional) planning take into account the river basin as a natural planning unit. As a first step, this can be done within existing institutions, by coordinating planning strategies and adapting them to the required spatial level. This process would be facilitated by establishing a focal point within national and subnational administrations. In addition, there is a need for political initiatives and economic incentives that promote consultation and coordination among the actors. Despite the fact that interdepartmental coordination within national and local administration would be an important step in making land and water management planning more efficient, the efficient integration of land and water resources may require the establishment of catchment organizations that would have a responsibility for planning from the main catchment level down to smaller "tributary units". This need to establish efficient water authorities and river basin plans was in fact already clearly recognized in 1977 at the United Nations Water Conference at Mar del Plata, Argentina.

28. Local (tributary) organizations should also be given a high degree of responsibility over the planning and use options of land and water resources under their jurisdiction, including the solution of conflicts among competing different water and land uses. If not already available, an inventory of local land and water resources should be compiled, and the social, economic and environmental requirements of all stakeholders need to be identified. Based on these assessments, basin organizations should develop different use options that aim at sustainable development in the long run. To have effective authority, basin organizations need to be empowered through national and local legislation and to have some means of financial autonomy. Provided that formal agreements are made among riparian States, an overarching river basin organization might deal with issues at the international level, that is, the sharing of water between countries, transboundary pollution, policy issues, technology transfers and financial issues. Another important task would be to seek ways of harmonizing policies, strategies and programmes so that similar, effective mechanisms from one area could be implemented elsewhere as needs arise. Both this overarching organization and local tributary organizations will need access to adequate physical, social and economic data in order to make appropriate and well balanced decisions.

29. It is important to initiate country-driven pilot projects that address the comprehensive nature of land and water resources systems and demonstrate the strong linkages that occur between such systems. The above-mentioned organizations, in cooperation with national Governments and international organizations, could have an important role in identifying such programmes, drawing up plans and initiating their implementation. The Committee on Natural Resources, at its third session, in 1996, urged Governments, with the support of the organizations of the United Nations system, other multilateral and bilateral organizations, and non-governmental organizations, to consider the possibility of establishing pilot projects on river basins and regions that were deemed to be suffering from serious water-related stresses with a view to developing and implementing policies designed to avert a water crisis.

30. Worldwide, there are four common threads to be found in river basins where integrated planning and management of land and water resources are rated as effective. First of all, a stable institutional framework that overcomes fragmentation and overlap of responsibilities, and is supported by comprehensive but flexible legislation and regulations, must be in place. This ensures fairness in basin-wide decisions and a process of accountability. Second, planners and stakeholders should have access to a strong knowledge base based on an accurate and comprehensive data network that allows the formulation, implementation and follow-up of sustainable natural resources development strategies. This ensures equity in defining solutions among and between the implementing agencies and water users. Third, full integration across all natural resource issues must be carried out, which implies that individual agencies look at impacts and improvements across the spectrum of natural resources. It also means that provincial and regional governments look at their natural resources base as a whole and attempt to achieve sustainability as a package, as opposed to attempting to maximize use of a single resource, such as water, soil or minerals. Last but not least, a programme for strong community awareness and

participation should be fully implemented. Most policies or decisions relative to the rehabilitation or exploitation of natural resources have a large impact on users, especially farmers. Unless the farmer understands these issues and is able to provide inputs into the decision-making process, users cannot be expected to give up some use or activity for the so-called common good. This is where it is important to find a "win-win" solution for all concerned, but particularly the farmer.

31. Within the river basin organization, two other components are essential for a sustainable, efficient and effective management. First, the organization must have its foundation and mandate in legislation that clearly identifies its functions, structure and financial base, and its operation must be based upon a decision-making process of authority, responsibility and accountability. Every decision made by a higher level body to be carried out must not only delegate responsibility but also commensurate authority and financial capacity. And every decision that is carried out by the lower-level body requires accountability of the action taken to the higher level body, through a systematic reporting process. If that process is properly carried out, the organization must internally carry out a planning, programming and budgeting system in which the operational body at the lower level will submit for consideration a plan, programme and budget for the higher-level policy and decision-making body to review and approve. Second, the organization must be conceived in the reality of existing conditions, where there are already vested interests, attitudes and economic bases; that is to say, there may (are) be already water and other resource agencies with similar mandates, but which operate along administrative or other jurisdictional boundaries, attitudes with respect to location and accessibility to water resources (upstream-downstream mentality), and current water and land uses and practices. Whenever and wherever reform movements of the nature and magnitude of comprehensive river basin management are introduced or expanded, there is resistance to change and concern over infringement on administrative level and agency "turf". To mitigate such resistance and ensure a successful reform (although this may take many years), it is necessary to adopt a strategy of communication, coordination and cooperation within the river basin organization and among the appropriate levels of government, agencies, water users and the community.

32. Relevant chapters of Agenda 21 recognize that many of the problems related to land and freshwater have arisen from a lack of adequately trained personnel, public awareness and education about surface and groundwater resources protection. Since extension services have traditionally been provided by sectoral institutions without proper coordination, starting to build the institutional capacity to deliver integrated services at the field level requires, above all, both high-level ministerial policy coordination and appropriate financial and human resources. Applying a multidisciplinary mix may need a refocusing of efforts at intermediate institutional levels and extensive retraining of extension officers. These efforts should ideally be supported not only by international, national and local support agencies, but also by the private sector and various non-governmental and scientific organizations.

33. The strengthening of institutional capacity also requires a strong educational, research and analytical infrastructure, primarily based on local and national expertise. Educational capacity needs to be built from a strong base, including primary education. At the national level, considerable efforts need to be made to promote the understanding of interactions between land use and management on the one hand, and quality and flow regimes of river systems and groundwater on the other. This is particularly important in rural areas, since non-point sources of pollution, including fertilizers and various toxic substances used in agriculture, is an increasingly serious problem worldwide. The scientific community, through universities and international organizations, has a responsibility to gather and present information that is accurate and comprehensive, and to provide practical assistance in the implementation of action-oriented programmes and initiatives. At the same time, Governments should promote and enhance the active participation of scientists in the policy and decision-making process.

34. As a complement to education programmes, public information campaigns are an important way of communicating with large groups in society. These campaigns should be based on information that is readily available and comprehensible to the general public, and should aim at promoting broad public interest in environmental issues. It is important that such campaigns be presented in a positive manner, demonstrating possible development options of interest to people at the local level. The technical revolution within the information and communication media (that is, the Internet), has enabled the cheap dissemination of vast amounts of information on these and other environmental issues. This, however, has not yet benefited a majority of the population in developing countries that presently lack the means to access these services. In order to be disseminated worldwide, assistance to develop national networks in developing countries is urgently needed.

35. Considerable attention has been paid to gender issues in some sectoral uses of water, specifically in domestic water

supply and sanitation. However, gender issues in the broader picture of land and water resources management have received much less attention. At the operational level, women are too often seen solely as users of domestic water and as a pool of volunteer labour with unlimited time and energy. Women are rarely treated as managers of water and land resources. Failure to encompass the diversity of water users, uses and institutions, combined with non-consultative processes of land and water allocations, have led to negative impacts on women, their families and the communities, and conflicts over water and land. The main constraints that women confront in achieving full integration and participation in water resources management are: (a) lack of education and training, (b) lack of participation in planning, programming and projects, (c) lack of information and awareness-raising methodologies, (d) lack of financial means, and (e) lack of choice of various types of technologies.

G. Transfer and adaptation of technologies

36. The efficient management of land and water resources is mostly a local or national issue, and will need to be defined for each area. Local and indigenous experience can be an important source of knowledge that is often ignored in traditional technical cooperation arrangements. Research into and adaptation of such knowledge for contemporary application can yield results that are cost-effective and sustainable. It is also important that technologies and training or education programmes be adapted to local conditions and local users. Appropriate technologies to improve land and water management exist, but their applications are limited by institutional and financial constraints, as well as lack of appropriate training and education. Transfer of technology is not automatically a solution to the underlying problems facing many countries, such as increased population pressure and land degradation, but can be an important component in combination with many other actions that might be needed, including measures to ensure adequate operation and maintenance at the local level.

37. Technology transfer schemes should also recognize that ongoing technological development is often driven by commercial considerations, so that investment in further research and development can be properly funded. Nonetheless, the least developed countries that have not benefited from the increase in private capital inflow need special attention. To address this issue, priority could possibly be given to low-cost technologies and the use of local resources, including raw materials, that could be promoted as environmentally feasible.

H. Mobilization of financial resources

38. Developing countries face a daunting situation. Although the challenges of developing sustainable financing of traditional subsectors (such as urban water supply and irrigation) have yet to be met, they simultaneously face enormous financial, technical and institutional challenges in managing their water and land resources in a sustainable integrated manner. The quality of the intertwined land and aquatic environment is a concern in all countries, but in many developing countries, the situation is acute. This is most obvious in cities where sewage and industrial effluents are rarely treated. There are also very major problems associated with inappropriate land and water use in agriculture. The financial resources required to deal adequately with these problems are often beyond the means of most countries. While official development assistance is an important source of finance in the poorest countries, in most developing countries, the bulk of investments required to tackle these problems will have to come from national sources. In order for this to happen, Governments need to foster an enabling environment that encourages investments from both public and private sources, and to allocate a significantly higher proportion of their budget expenditures to public investments in sanitation and sewage treatment in order to control the adverse environmental health impact on both land and water ecosystems. This will often include measures to ensure cost recovery of improved service provision, as the Umgeni example clearly shows (see box 2). In fact, greater attention needs to be given to the use of economic instruments, such as pollution charges and taxes on fertilizers and pesticides, to control the discharge of industrial effluents and non-point sources of pollution in agriculture.

39. As discussed in a paper prepared for an expert group meeting on strategic approaches to freshwater management[2] held at Harare in January 1998, it is possible to identify two major approaches to dealing with environmental standards and the costs required to achieve those standards. The first approach can be characterized as the "set-the-standards-and-then-raise-the-money" approach. The prime example of this approach is the European Union, where the magnitude of investments required to meet standards is staggering. Germany, for example, needs to invest an estimated $300 billion if existing water quality standards are to be met. At current (high) investment levels, this would take 40 years to achieve. The second approach is one in which

Box 2. Umgeni water board: expanding access to improved levels of services through the private sector[3]

Umgeni Water, the largest water utility in the province of Natal, South Africa, takes a long-term view in the provision of water supply to a catchment of 24,000 km and a population of 5.5 million people, of which 1.5 million is rural. Development and growth has put the water resources under stress. The utility identified a major source of pollution to be from the discharge of raw and untreated sewage into the basin resulting from increased urbanization and informal settlements. In addition, soil erosion in the headwaters was causing increasing silt loads in rivers and reservoirs. As a result, the cost of water supply to urban users was increasing due to expensive treatment processes.

To counter these long-term effects, the utility started providing water supply to rural areas, also demonstrating that services could be provided jointly to rural, peri-urban and urban areas in a cost-effective manner, with full cost recovery for the operations and maintenance cost. The utility covered the capital cost by a capital subsidy from the urban to the rural areas, which – when a broader perspective is taken of the environment and long-term cost price relationships – is essentially seen to be of benefit to the urban dwellers. The utility charges households the full capital cost for house connections and recovers the full recurrent costs. Umgeni Water is a parastatal that receives no subsidy. It is triple A rated on the stock market and issues its own bonds.

environmental quality and the required financing are considered simultaneously. The origin of this approach was in the Ruhr basin in Germany at the time of the First World War; the approach was subsequently (in 1960) adapted by France on a national scale, and it is now being used in several developing countries. The new Brazilian water law, for example, incorporates many of the lessons of the Ruhr/French experience.

40. The Ruhr-French approach is based on a coherent set of institutional and instrument principles. The "institutional principles" are those of participation, subsidiarity and technical efficiency. With respect to participation, the French river basin financing Agencies provide a good model – 60 to 120 parliamentarians, representing all users and interested parties, choose the vector of water quality and cost appropriate for their basin, and decide on the assignment of costs among the public and private parties involved. With respect to subsidiarity, the basin agencies are careful never to do anything that can and should be done at a lower level, such as a municipality or irrigation district. Thus, although the basin agency decides on abstraction and pollution charges, it has nothing to say about whether a city chooses to have a public or private agency operate its water supply. With respect to technical efficiency, this model depends heavily on strong technical basin agencies, which ensure that basin management is scientifically and technically sound and advise the water parliament on the trade-offs between standards and costs, and on how best to deploy available resources.

Notes

[1] Robert Young, *Measuring the Economic Benefits for Water Investments and Policies*, World Bank Policy Paper, No 338 (Washington, D.C., 1996).

[2] John Briscoe, "The financing of hydropower, irrigation and water supply infrastructure in developing countries".

[3] Discussed in a paper by Ashok Nigam and Sadiq Rasheed, entitled "Financing of freshwater for all: a rights-based approach", submitted to an expert group meeting on strategic approaches to freshwater management, Harare, from 27 to 30 January 1998.